

# LOUSE POWDER STUDIES IN NORTH AFRICA

(1943)

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## INTRODUCTION

Severe and extensive outbreaks of typhus fever occurred in both Algiers and Morocco during the winters of 1941-1942 and 1942-1943. A survey visit to this area by Mr. Richard ALLEN of the American Red Cross, and Dr. George K. STRODE of the International Health Division of the Rockefeller Foundation in January 1943 led to negotiations with Dr. Edmund SERGENT, Director of the Pasteur Institute of Algiers, with Dr. GRENOILLEAU, Director of Health for Algeria, and Dr. GAUD, Director of Health for Morocco, for collaboration in studying methods of typhus control, based on the use of insecticidal powders. The American Red Cross sponsored the studies which were undertaken with the approval of the State Department.

The Rockefeller Foundation Health Commission assigned Doctors Fred L. SOPER, William A. DAVIS, Floyd S. MARKHAM and Louis A. RIEHL to the project. Through transportation facilities provided by the War Department and the Surgeon General's Office this group came to North Africa late in June 1943 and established contact with the Pasteur Institute of Algiers, the Health Department of Algeria and the Medical Section of NATOUSA.

Plans were made for the initial testing of materials and methods in collaboration with the Pasteur Institute of Algiers. Demonstrations of epidemic control measures were planned in both Morocco and Algeria, if epidemic typhus again became a serious problem during the ensuing winter season.

The initial activities were devoted to : (1) evaluating the effectiveness of different louse powders on natural infestations ; (2) studying locally available excipients for the preparation of louse powder ; (3) testing the feasibility of mixing DDT powder in the field ; (4) determining the duration of effect of insecticides in the face of constant reinfestation ; (5) developing methods for the rapid

application of powder to the individual; and (6) developing administrative methods for rapidly and economically delousing communities for the purpose of blocking the spread of epidemic typhus.

Considerable difficulty was encountered in securing adequate supplies, transportation and personnel for the field studies, and the program proceeded more slowly than had been anticipated. However, during the following months the initial testing of materials and methods in a civilian prison was completed, and field demonstrations of delousing without the removal of the clothing had been made in Prisoner of War Camps and in the county of L'Arba, Algeria. The anticipated epidemic conditions required for field control demonstrations had not developed in North Africa when the rapid increase of typhus in Naples, Italy, led to a transfer of this part of the program to that city on December 8th, 1943, under the auspices of the Allied Military Government. This epidemic in a non-immune population, well seeded with typhus at the beginning of winter, afforded an unexcelled opportunity for the rapid and dramatic demonstration of the practical value of the method of delousing without removal of clothing developed in Algeria.

The present report covers (1) intensive studies carried out at the Maison-Carrée Prison near Algiers on the relative efficacy of factory-prepared MYL powder and powders containing DDT prepared with local excipients and applied by various methods; (2) the extensive field application of insecticide to the general population of the town and county of L'Arba in Algeria, and (3) a rapid field test in a Prisoner of War Camp, of the new factory prepared U. S. Army — 10% DDT pyrophyllite powder.

The most important developments of the work in North Africa were: (1) the demonstration, on naturally acquired infestations, that both MYL and DDT are highly efficient pediculicides, (2) the development of the air-blown application of louse powder without removal of clothing from the body of the person being deloused; (3) the demonstration that lousy people will take the trouble to come to accessible delousing stations to get relief; (4) the development of administrative methods for the rapid disinsectization of both military and civilian populations.

#### PERSONNEL ENGAGED IN STUDIES.

In Algiers, Dr. Edmund SERGENT, Director of the Pasteur Institute, took a personal interest in the program from the beginning and assigned Dr. BÉGUET as the representative of the Pasteur Institute to follow the scientific aspects of the work. Dr. Paul BUCK was assigned from the staff of the Pasteur Institute to work with the Foundation group in the actual application of insecticide and

in ascertaining the degree of louse infestation before and after treatment.

Col. W. S. STONE of the Medical Section of NATOUSA was kept informed of the plans of these studies and was of great assistance in making available needed materials with which to work. Col. STONE was also instrumental in assigning a number of officers from Malaria Units to work in the field application of insecticide at L'Arba. Several of these officers later took an active part in the Naples campaign.

Dr. SERGENT was responsible for making arrangements with M. le Directeur de la Sécurité Générale du Gouvernement Général for the studies at the Maison-Carrée Prison and with M. le Préfet du département d'Alger and the Président de la Délégation spéciale of L'Arba for the work in that county.

All details of the work and the observations herewith reported are the direct responsibility of the Rockefeller Foundation Health Commission Typhus Team and Dr. Paul BUCK.

## MATERIALS

### *Insecticides*

Initial plans called for the study in North Africa of various newly synthesized insecticides in an attempt to develop a formula better than the MYL of the United States Army. By the time the work began in North Africa, however, the laboratory tests of the new insecticide, DDT, had proceeded far enough to warrant concentrating efforts on field studies of MYL and DDT preparations.

*MYL Insecticidal Powder of the U. S. Army.* — The MYL powder tested in the Maison-Carrée Prison was part of a shipment of powder manufactured by the McCormick Company of Baltimore which had arrived in Algeria in April 1943. This material was packed in 2 ounce shaker tins. The MYL powder used in the field at L'Arba was material ordered early in 1943 from the McCormick Company and packed in specially designed 2 ounce envelopes. The shipment arrived in Algeria in July of the same year.

*DDT (2,2-bis (p-chlorophenyl)-1,1,1-trichloroethane).* — When the North African studies began there was available a small lot of 5 pounds of DDT which had been received for field tests from Mr. KNIPLING at the Orlando Laboratory of the U. S. Department of Agriculture. An additional 30 pounds of DDT was received later from the Medical Section NATOUSA, which also furnished the 10% DDT pyrophyllite powder used in the Prisoner of War camps.

*Cresylacetate-2,4.* — 2,4 Dinitro Cresylacetate was tested in combination with DDT in a single experiment at Maison-Carrée.

*Hair Lotion.* — The air lotion used at L'Arba was a modification of that described by DAVIS<sup>(1)</sup>. An emulsion of the active ingredient, phenyl cellosolve, was made in water by the use of a sodium alkyl sulphate, Tergitol 07, at a concentration of 0.1 per cent. Since phenyl cellosolve and Tergitol 07 are miscible liquids, a stock emulsion may be prepared and used as required.

The emulsion was easily and simply prepared. Five per cent by volume of the stock solution of phenyl cellosolve and Tergitol 07 was placed in a container of convenient size, such as a one-litre wine bottle. After the proper volume of water had been added and the bottle corked, the mixture was shaken vigorously before application. The suspension separates on standing for several hours but can be quickly re-established by shaking.

*Diluents for Insecticide* (Barytes, barium sulphate,  $\text{Ba}_2\text{SO}_4$ ). — Barytes is mined at Maison-Carrée only a short distance from the prison where tests were carried out. Two samples of this material were received from the Cie « Produits barytiques Nord-africains ». The sample « Blanc Extra Fin » as found to be sticky but the « Extra Blanc » proved to be a suitable fine smooth white powder with little or no tendency to stickiness. It passed a 200 per inch mesh screen easily and had a pH of 6.8 but was very heavy, being over three times the weight of pyrophyllite used in the preparation of MYL.

*Cement Dust.* — The Société Lafarge, at Point Pescade, a suburb of Algiers, furnished a finely ground limestone which is used in the manufacture of cement. Chemical analysis showed this limestone to consist mostly of calcium carbonate with some magnesium carbonate and oxides of silica, aluminium and iron. This limestone powder was a dirty gray-brown in color, was gritty to the touch and had a pH of 9.0. It was, however, much lighter than the barytes, weighing approximately the same as does pyrophyllite.

#### *Preparation of Insecticides*

(1) *Solvent Method.* — Suitable quantities of DDT concentrate (100%) and the excipient were weighed out. The DDT concentrate was then completely dissolved in a volume of acetone sufficient to yield a workably wet paste when the solution was added to the excipient. The resulting paste mixture was stirred thoroughly and continuously until the bulk of the acetone had evaporated leaving the active ingredient evenly distributed on the excipient. The

(1) DAVIS, W. A., 1943, *Journ. Am. Med. Assn* ; Vol. 123, p. 825.

slight amount of acetone remaining evaporated when the mixture was spread in a thin layer on a paper-covered surface for final drying.

(2) *Mechanical Methods.* — A. *Hand Mixer*: Weighed amounts of the active ingredients and excipients were placed in the baffle chamber of a small hand operated mixer and rotated for specified time intervals. The mixing chamber was fitted with baffleplates and excentrically placed on the surface of a revolving disc so that maximum distribution and mixing of the components could be obtained. When more than one sample was prepared for use in the same experiment the batches were mixed for equal periods of time.

B. *Bread Mixer*: Two batches of 10% DDT powder were prepared in a bakery-type bread mixer. The machine consisted of a large cast iron tub which rotated freely in the horizontal axis and an eccentrically places set of mixing paddles which caused the tub to revolve slowly as the paddles moved through the contents of mixing chamber. From time to time during the mixing period the paddle action was augmented by manual redistribution of the materials in the tub. DDT concentrate becomes hard and lumpy on standing and must be milled shortly before mixing. Since the melting point of DDT is relatively low, the heat generated at the grinding surfaces of the mill produces a slight stickiness which prevents a smooth blend with the excipient in a bread mixer. This can be avoided if a certain amount of excipient be added to the DDT concentrate at the time of milling.

*Hot table.* — When clothing is examined to determine the incidence and degree of lousiness, searching the seams becomes a laborious task, and any simple means of driving out the lice greatly facilitates their discovery. The louse has a limited adaptation to temperature, and a slight increase of heat causes it to move about and leave the seams. The louse generally crawls upwards and, even though negatively phototropic, will expose itself to light to escape heat applied beneath it. The heat applied must be moderate to avoid stupefaction or even death of the insect.

During the early work at the Maison-Carrée Prison it was found that effective use could be made of sunlight to heat a black metal surface which served as a « hot table » on which clothing was examined. Lice present in the clothes emerged from the seams and crawled about the exposed surface of the garments. As the season advanced a kerosene stove was placed below the metal surface with fair results. Later, a cylindrical barrel frame with a superimposed rack for suspending clothing at an angle in the warm current of air rising in the barrel was placed around the kerosene stove. This arrangement was not entirely satisfactory but proved useful in the final examination of clothing not obviously infested.

### *Applicators of Insecticide*

*Shaker Tins.* — Previous experience led to the use of a special type of shaker tin for the application of MYL, which is too moist and sticky to sift well from the tin in which it is packed. The shaker tins used in North Africa were made by drilling one or two rows of holes in the side wall about the base of a cylindrical tin can having a diameter of three and one-half inches. With the perforations in the side wall (not in the bottom of the tin) it is possible to keep the powder flowing continuously by rotating the tin slightly with each shake.

*Agricultural Dusters.* — The agricultural dusters used were of two types (trade names, Toxine and Corona) both used by the wine growers in North Africa for the dusting of their vineyards.

The Toxine duster is a bellows type knapsack duster in which the dust is picked up by an air stream directed downwards on the surface of the powder and carried out through an aperture placed near the top of the chamber.

The Corona duster is a bellows type knapsack duster in which the powder drops from the hopper into a tube below. The air stream picks up the dust as it passes through the tube.

Attempts were made to adapt the Hudson Rotary Powder Duster No. 608 for the application of MYL powder to clothed individuals, but the physical properties of this powder as well as the mechanical design of the duster rendered its use impractical.

*Hand Dusters: Hudson, Cadet-Major, Plunger Type.* — The powder chamber is immediately in front of the compression chamber, forming with it a continuous tube with an air valve located in center of partition separating the two chambers. The outlet aperture for dust consists of an axial tube, beginning about one-third of the length of the chamber from its distal end. Powder tends to pack around the outlet tube and discharge as « slugs ». The axial inlet and outlet tubes, together with its small capacity cause this duster to be relatively inefficient. However, it can be used in an emergency to good advantage, as was demonstrated later in the Naples epidemic.

*Dobbins « Superbuilt » No. 133. Plunger Type.* — Air passes from compression chamber through a tube placed at the circumference of the powder chamber and enters the powder chamber at the distal end. Outlet consists of a series of apertures well back of the distal end opening into a delivery tube placed diametrically opposite the inlet tube. When the duster is held so that the outlet tube is on the upper side, the air, en route from the inlet to the outlet, must pass upward through the powder carrying some of it into the air space of the powder chamber and thence out through the delivery outlet. This (together with the similar Hudson Admiral Duster N°. 765) proved to be a highly satisfactory tool for applying louse powder.

*DeVilbiss Hand Power Sprayer Outfit and Modified Dust Guns. For use with portable power compressor units.* — The DeVilbiss Sprayer outfit N°. TZ-601 is a hand operated unit consisting of a compressor to which is attached a spray gun fitted with a glass or metal container for liquids. The gun was modified to use positive rather than negative pressure, but was found to be unsatisfactory because of the continued demand for high pressure required for its operation.

The modified De Vilbiss sprayer gun and several others built through the cooperation of the Surgeon's Office NATOUSA and the U. S. Army Air Corps shops were used with varying degrees of success when attached to gasoline driven air compressor units. In general the limitations of this type of equipment are: (a) the ability of the compressor unit to maintain sufficient pressure to operate two or more guns continuously; (b) the ability of the powder chamber to withstand the abrasive action of the excipient dust; (c) the facility with which the powder chamber can be refilled and (d) the need for mechanically trained operators to care for the equipment.

## METHODS

### *Determination of louse infestation*

The degree of louse infestation was determined with varying degrees of thoroughness. In work at the Maison-Carrée Prison the degree of lousiness of each individual was determined by removing all of the clothing and carefully examining the inner surfaces and seams for lice. In preliminary survey work, when an incomplete search revealed the presence of ten or more lice, the individual was registered at 10<sup>(1)</sup> plus. In post-treatment examinations all garments were examined and complete counts made.

The examinations were generally made in bright sunlight and negative garments were often subjected to hottable treatment to aid in the discovery in insects.

The classification of post-treatment of lice as to stage of development was found to be very useful in evaluating the insecticide tested. Each insect was recorded as newly hatched, immature or adult. The post-treatment finding of only newly hatched lice indicates that the insecticide, although not ovicidal, has a persistent action which destroys the instars before they reach the nymphal or adult

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(1) Previous experience in community surveys had shown that populations can be roughly divided into two groups; those having not over 9 lice and those having 10 or more. Most of the persons falling in the first group will be found to have not more than 5 lice.

stages. The finding of immature forms on treated garments is not necessarily an indication for repeated treatment.

At L'Arba the subjects were not disrobed to determine the degree of louse infestation. A louse-index based on a rapid examination of the clothing about the collar and over the shoulders was considered sufficient for the purpose of this study.

At Maison-Carrée Prison all examinations were carried out by members of the Rockefeller Foundation Typhus Team or Dr. BUCK, with a few specially trained prisoners working under their direct supervision.

### *Application of Powder*

*Shaker Tin.* — If bedding is to be treated the blankets are first spread out flat on the floor or table top and lightly dusted with powder from the shaker tin. The blanket is then folded once-over. Next, the upper garments after having been turned inside-out are laid one by one in the center of the folded blanket and dusted individually. Particular care is taken to ensure thorough powdering of the neckband, and the seams about the shoulders, arms and waist. Coats, shirts and under-shirts are treated alike. The lower garments after being turned inside-out are treated in the same fashion. The side-seams of the trousers and the seams about the waistband, seat and crotch of both the trousers and underwear are heavily powdered. A certain amount of powder can be worked under the overlapping seams of the trousers by a brisk back and forth brushing movement over the surface of the garment. The inside of the hat or cap is then powdered and added to the pile in the center of the blanket.

Finally the corners of the blanket are folded over the dusted clothing so as to form a closed bundle which is given several smart blows at the sides and top in order to fluff the powder throughout the treated garments and blanket. If blankets are not being treated, the overcoat or waistcoat may be used as the covering of the bundle of clothing in the final step.

*Mechanical Dust Pumps.* — Essentially the same technique is employed in applying powder with both the hand operated and the powder-driven compressed air dust pumps.

The following paragraphs are quoted from the directions for powdering prepared 2 November, 1943:

#### *« Powdering Technique »*

« In using the duster, the operator should remember that powder should be distributed on the inner surfaces of the inner garments and on the skin itself. Those doing the work for the first time should have the clothing removed from the first persons powdered to observe the results obtained. If properly done, the entire inner garments should be more or

less completely covered with powder and there should be visible powder on the body hairs of the chest, back, thighs, armpits and of the pubic and perineal regions. Since body lice are most often found in the seams of the clothes about the neck, armpits, waist, shirt-tail and crotch of the pants, these areas are particularly important ones to be powdered.

« The dusting of individuals should follow a certain routine to avoid missing some parts of the clothing as must occur at times where each person is handled differently. The following routine has been found useful :

1. — Dust inside of hat and replace hat on head.

2. — With arms extended at shoulder height at the sides (not in front of the body) insert delivery tube up first the right and then the left sleeve and pump powder in between the skin and the innermost garment. Powder should reach well into the armpit and the position of the gun should be shifted to get powder all about the shoulder.

« In case the subject is wearing more than one layer of clothing, dust should be applied between his underwear and shirt as well as between the underwear and the skin.

3. — The delivery tube is next inserted at the back of the neck and a liberal charge of powder shot down the back, care being taken to dust the neckband itself.

4. — The tube is next inserted inside the clothing from in front and powder sprayed first on one side, then on the chest and lastly on the other side, special care being taken to again reach the armpits.

5. — The tube is next inserted, after the trousers are loosened, inside the innermost garment and a good dose of powder delivered to the crotch and pubic area. With the tube still in contact with the skin, the under-clothing is powdered, special attention being paid to the waist and side seams.

6. — With the trousers still loose, the tube is inserted down the rear of the pants next the skin and powder is shot down over the buttocks and rear of the crotch.

« Note : if more than one layer of clothing is being worn, steps 3, 4, 5 and 6 above are repeated for the second layer from the skin. »

## SECTION I : STUDIES AT THE MAISON-CARRÉE PRISON

The Maison-Carrée Prison had, at the time of these studies, approximately 1,000 prisoners, accommodated in three wards, two for males, one for females. Only small demonstrations were attempted in the ward for females and no further reference will be made to the work there. The male prisoners, most of whom were Arabs, differed in prison status, clothing and living conditions.

A considerable number of prisoners were employed as trustees in handling the others. These trustees received better food, clothing and quarters than did the other prisoners. Special concessions were made also for mechanics, cooks and other specialized workers.

Some prisoners, especially those serving short sentences, had friends or relatives with sufficient funds to supply them with extra food, soap and clothing. These were considerably better off than were prisoners depending entirely on prison issues. The latter were obviously under-nourished and had little or no soap for washing

the trousers, jacket and blanket which comprised their entire wardrobe.

The prison routine calls for the use of woolen clothing in winter and heavy cotton in summer. Due to the war and scarcity of materials, summer clothing had not been issued to many of the prisoners and numbers of them continued to wear winter woollens throughout the summer.

The work of the prisoners at Maison-Carrée varied according to the length of sentence imposed. Thus the prisoners in Ward I were of two groups, those condemned for life and those confined for minor offenses. The minor offenders were hired out in gangs to do agricultural work outside the prison grounds, whereas the lifers worked in the open courtyard of the ward at relatively light labor weaving mats and baskets for which they received a small stipend. The lifers in Ward I had not been issued summer clothing whereas most of the short termers wore cottons.

The majority of prisoners in Ward II had been sentenced to forced labor. These men worked at hard physical labor preparing fiber for basket and mat weaving. This work was done under guards in a large room where the prisoners were crowded together on the floor.

Prisoners in both Wards I and II were provided with fiber mats and blankets and slept in groups of 80 in large dormitories where they were confined from 5:30 in the afternoon until 7 AM.

Because of the intimate contact and crowding, particularly in Ward II, the opportunity for a daily interchange of parasites was excellent. Under these conditions only the most industrious of the prisoners were able to keep themselves relatively free of lice. The steam sterilization plant at the prison was little used, because of shortage of fuel and mechanical breakdowns.

The first visit to Maison-Carrée was made on 23 July with Dr. BÉGUER at which time arrangements were made with the Director of the prison for beginning work. Work began with a preliminary pre-powdering louse survey, July 26 to 29. This survey (Table I, Groups 1, 2, 3, 4) revealed 153 lousy prisoners among 158 examined, 116 of whom had more than 10 lice each. Further surveys of unpowdered individuals were made from this time on through the end of October (Table I, Groups 4, 13, 14, 23 and 24) with the finding of even higher degrees of infestation. From these results it is clear that any reduction from the July level noted in the louse burden of test groups must be attributed to the insecticide used.

The materials and methods used on 24 groups of prisoners at Maison-Carrée are outlined in Table II.

### *Experiment I*

The initial test at Maison-Carrée was to compare the action of repeated doses of 5% DDT in barytes and of MYL on natural

infestations in an environment where exposure to reinfestation from untreated persons could be almost entirely prevented.

Ward I was chosen for the first test with observations in Ward II to serve as a check against the possibility of a seasonal reduction of louse incidence being attributed to the use of insecticide.

The prisoners were called by number and checked off as the clothing of each man was dusted by hand (shaker tins).

TABLE I: LOUSE COUNTS ON UNPOWDERED GROUPS  
AT MAISON-CARRÉE PRISON

Date	Ward	Group Number	Number Examined	With Lice	Over 9 Lice	% Over 9 Lice	Per Cent Lousy	Average Number of Lice
7/26-29	1	1, 2, 3	108	104	77	71	96	10 +
	2	4	50	49	39	78	98	10 +
8/9	2	4	48	48	44	92	100	10 +
8/29	2	13,14	20	20	20	100	100	10 +
9/6	2	13,14	20	20	17	85	100	10 +
9/13	2	13,14	20	20	20	100	100	10 +
9/20	2	13,14	20	19	16	84	95	29
9/27	2	13,14	17	17	15	88	100	38
9/30	2	23,24	20	20	18	90	100	37
10/8	2	23,24	19	19	17	86	100	72
10/15	2	23,24	18	18	17	94	100	157
10/22	2	23,24	18	18	16	89	100	102
10/29	2	23,24	18	18	15	83	100	90

The 108 men examined in Ward I (Groups 1, 2, 3) were divided into three groups of 36 men each, and hand dusted (shaker tins) as follows:

The clothing and blankets of the men in Group 1 were treated with 5% DDT in barytes (barium sulphate) and redusted with the same material 17 days later; those of the men in Group 2 were dusted twice at a 7 day interval, and those of Group 3 twice at a 14 day interval with MYL.

All other inmates of Ward I were treated with MYL twice with an interval of 14 days to prevent them from grossly reinfesting the study groups.

TABLE II. — MATERIALS AND METHODS USED ON 24 GROUPS OF PRISONERS IN EXPERIMENTS I, II AND III  
AT MAISON-CARRÉE PRISON.

Group	Experiment	INSECTICIDE			Treat- ments	Inter- val, days	Applied by	PERSONS TREATED				Insect- icide, ounces
		Chemical	Percent	Excipient				Subjects	Contacts	Blank- ets	Blank- ets	
1	I	DDT	5	Barytes	Solvent	2	Shaker	+++	+++	+++	+	?
2	I	MYL	—	Pyrophyllite	Factory	2	Shaker	+++	+++	+++	+	?
3	I	MYL	—	C O N T	R O L	2	Shaker	+++	+++	+++	+	?
4	I	—	—	Barytes	Solvent	—	—	+++	+++	+++	+	0
5	II	DDT	5	Barytes	Solvent	1	Agric. Ⓞ	+++	+++	+++	+	0.6
6	II	DDT	5	Barytes	Solvent	1	Shaker	+++	+++	+++	+	1.5
7	II	DDT	5	Barytes	Mech.	1	Agric. Ⓞ	+++	+++	+++	+	0.8
8	II	DDT	5	Barytes	Mech.	1	Shaker	+++	+++	+++	+	4.8
9	II	DDT	40	Barytes	Mech.	1	Agric. Ⓞ	+++	+++	+++	+	0.8
10	II	DDT	40	Barytes	Mech.	1	Shaker	+++	+++	+++	+	4.7
11	II	DDT	40	Cement dust	Mech.	1	Agric. Ⓞ	+++	+++	+++	+	0.8
12	II	DDT	40	C O N T	Mech.	1	Shaker	+++	+++	+++	+	1.5
13	II	—	—	C O N T	R O L	—	—	+++	+++	+++	+	0
14	II	—	—	C O N T	R O L	—	—	+++	+++	+++	+	0
15	III	DDT + 2%	40	Cement dust	Mech.	1	Agric. 藥	+++	+++	+++	+	2.0
16	III	DDT	40	Cement dust	Mech.	1	Shaker	+++	+++	+++	+	1.6
17	III	DDT	40	Cement dust	Mech.	1	Agric. 藥	+++	+++	+++	+	2.0
18	III	DDT	40	Cement dust	Mech.	1	Shaker	+++	+++	+++	+	1.6
19	III	MYL	40	Pyrophyllite	Factory	1	Dobbins	+++	+++	+++	+	1.8
20	III	MYL	—	—	—	1	Shaker	+++	+++	+++	+	4.8
21	III	Hand	—	—	—	1	Hand picking	+++	+++	+++	+	0
22	III	Hand	—	—	—	1	Hand picking	+++	+++	+++	+	0
23	III	—	—	C O N T	R O L	5	—	+++	+++	+++	+	0
24	III	—	—	C O N T	R O L	5	—	+++	+++	+++	+	0

Ⓞ : — Toxine

藥 : — Corona

\* : — Cresyl Acetate

Insecticide MYL was applied also to the garments of all new prisoners coming to Ward I and to those returning to the ward after a stay in the prison infirmary.

So far as is known, the only prisoners in Ward I to escape the initial dusting were three who assisted the guards in the administration of the ward and 15 who worked in the bakery. These assistant guards were dusted three days and the bakers 13 days after the rest of the prisoners. This failure to dust all simultaneously is probably of little importance, since these 18 men all enjoyed special privileges, had separate quarters and were much cleaner than the common run of prisoners.

The clothing and blankets of Groups 1, 2 and 3 were examined at intervals after both first and second treatments. In pre-treatment examinations, counts were discontinued on any given individual when 10 lice had been found, but post-treatment examinations covered the entire inner surface of all clothing worn and both sides of blankets.

The first post-treatment counts on Groups 1, 2 and 3 showed that both DDT and MYL had been very effective in reducing the louse burden of the treated prisoners (Table III). The two to four day counts indicated that the immediate effect of DDT had been somewhat less than that of MYL, but the 7, 10 and 14 day counts definitely favored DDT. The DDT-treated group showed a steady decline in numbers of lice up to the 17th day, when it was retreated. The hatching of young had apparently ceased by the 10th or 11th day. In the MYL treated groups, 2 to 4 day counts were lower than 7 day counts and in the group not re-treated until the 14th day, there was a decline in the louse infestation between the 7th and 14th days with hatching of young forms practically nil between the 10th and 14th days. The striking reduction in adult forms in all three groups is most significant, since the egg laying function on which the species depends for continued existence is a function of adult life.

The second treatment of Group I with DDT seventeen days after the first, was followed by examinations at 7, 13, 25 and 39 days after this second treatment, with practically no lice being found.

The last examination of this group, made 67 days after the second treatment (83 days after the first treatment) showed that about a third of the group was again lightly infested. This infestation was so slight that the prisoners still considered themselves louse-free.

Examinations of the MYL treated groups (2 and 3) failed in both cases to reveal the presence of an appreciable number of lice for some weeks. As was to be expected, evidence of reinfestation was found earlier, in groupe 2, retreated after 7 days, than in groupe 3, which was re-treated at an interval of 14 days.

TABLE III. — EXPERIMENT I: MAISON-CARRÉE PRISON. REPEATED LOUSE SURVEYS IN RE-TREATED GROUPS \*

Date of Exam.	Days before Treatment	Group 1 5% DDT-Barytes Re-treated after 17 days						Group 2 MYL-Pyrophylite Re-treated after 7 days						Group 3 MYL-Pyrophylite Re-treated after 14 days					
		No. Exam'd	No. pos.	No. Lice 9+	LICE (1)			No. Exam'd	No. pos.	No. Lice 9+	LICE			No. Exam'd	No. pos.	No. Lice 9+	LICE		
					I	N	A				I	N	A				I	N	A
7/26 *	8	36	38	25	53	474	231	34	33	26	53	244	136	34	32	23	44	245	151
After Treatment																			
8/5-7	2-4	36	27	3	445	7	8	34	18	1	41	2	0	34	18	0	32	5	1
8/10	6-7	35	49	0	60	8	3	34	24	3	76	48	5	34	22	5	98	21	1
8/13	10	35	6	0	1	43	0	34	0	0	0	0	0	34	15	2	23	51	5
8/17	14	35	6	0	0	6	1	—	Not Examined			—			Group re-treated				
8/20	17	36	6	0	1	1	8	32	1	0	0	1	0	—	Not Examined				
8/27	24	33	2	0	0	1	1	33	0	0	0	0	0	32	0	0	0	0	0
9/2	30	32	0	0	0	0	0	32	1	0	0	0	1	33	0	0	0	0	0
9/14	42	33	0	0	0	0	0	29	1	1	0	11	4	32	2	0	1	1	1
9/28	56	30	1	0	0	1	0	27	2	1	0	18	40	30	2	0	0	9	1
10/25	83	34	11	2	43	53	11	31	49	8	41	236	96	31	41	2	43	31	18

(1) I : — Instar  
N : — Nymph  
A : — Adult

\* For comparable conditions in untreated prisoners during the same season see data in Table I for prisoners in Ward II.

\* All counts on July 26th were partial counts.

In all three groups, negligible infestations were found at the end of 56 days after first treatment. The difference in the degree of infestation of groups 1 and 3, re-treated after 17 days and 14 days, and of group 2, retreated after only 7 days is probably significant.

*Discussion.* — A study of the behaviour of the louse population on groups 1 and 3 before re-treatment suggests that for the maximum result with the minimum amount of insecticide, the period between treatments may well be longer than 17 and 14 days.

Theoretically an insecticide which is fully effective immediately against all forms present except the ova but which has no delayed residual action should be repeated at about 14 days to catch the early post-treatment-hatched lice before they come into active egg laying. With the demonstration of continued activity of the insecticide this period may be lengthened accordingly.

From the epidemiological standpoint, it should be emphasized that the post-treatment counts are complete counts based on a thorough search in the seams of the clothing and an examination of blankets. The degree of lousiness found 83 days after treatment began was not such as to have permitted the rapid dissemination of typhus in the ward, had it been introduced. It seems reasonable to suggest on the basis of these counts that a population which has been thoroughly powdered twice may be considered safe from important outbreaks of typhus for at least a three month period.

The results in Ward I suggest that the complete eradication of lice in an institution or even in a community may be feasible with the proper application of either MYL or DDT.

### *Experiment II*

Experiments II and III carried out in Ward 2 were designed to test, under conditions favoring reinfestation, the action of single doses of 5% DDT, of 10% DDT, prepared in various ways and of factory prepared MYL, applied in various ways. An additional accidental variable was introduced in Experiment II through the failure of mechanical equipment used to apply the same amount of insecticide as was applied by hand.

Whereas in Experiment I, the possibility of reinfestation was reduced to a minimum, reinfestation was favored in Experiments II and III. Only the clothing of the prisoners in these experiments was powdered; their infested blankets were ignored. The remaining prisoners of Ward 2, where conditions were more favorable to reinfestation than in Ward I, were not powdered. Intimate contact continued between treated and untreated individuals both day and night.

In Experiment II eight groups of ten men each were treated with varying combinations of DDT, barytes and cement dust, some by hand shaker application, and others by agricultural mechanical

TABLE IV. — EXPERIMENT II : RESULTS OF VARYING THE CONCENTRATION OF DDT, THE CHOICE OF DILUENT, THE METHOD OF PREPARATION, THE METHOD OF APPLICATION AND THE AMOUNT APPLIED.

Insecticide Diluent Mix Application Amount GROUP	5 % DDT Barytes Solvent Pump 6 oz.		5 % DDT Barytes Solvent Hand 45 oz.		5 % DDT Barytes Mechanical Hand 8 oz.		5 % DDT Barytes Mechanical Hand 18 oz.		5 % DDT Barytes Mechanical Pump 8 oz.	
	Pos	Ex	Pos	Ex	Pos	Ex	Pos	Ex	Pos	Ex
1 day before	40	40	40	40	40	40	40	40	40	40
7 days after	40	40	40	40	40	40	40	40	40	40
14 days after	10	3	40	40	40	40	40	40	40	40
21 days after	9	8	8	9	8	8	9	9	9	9
23 days after	9	6	9	8	6	6	7	8	5	9

  

SECTION A : Distribution of infestation and number of heavy infestations.

	9 +		9 +		9 +		9 +		9 +	
	Ex	Pos	Ex	Pos	Ex	Pos	Ex	Pos	Ex	Pos
1 day before	40	40	40	40	40	40	40	40	40	40
7 days after	40	40	40	40	40	40	40	40	40	40
14 days after	10	3	40	40	40	40	40	40	40	40
21 days after	9	8	8	9	8	8	9	9	9	9
23 days after	9	6	9	8	6	6	7	8	5	9

  

SECTION B : Average number of lice of each stage, instar, nymph and adult.

	A		A		A		A		A	
	I	N	I	N	I	N	I	N	I	N
1 day before	plus	plus	plus	plus	plus	plus	plus	plus	plus	plus
7 days after	4.2	2.5	2.3	0.9	1.6	2.3	3.8	0.8	4.6	0.8
14 days after	0.5	2.5	3.7	0	0.9	2.9	4.5	2.0	1.4	4.0
21 days after	0.9	4.2	4.8	1.6	2.9	3.0	4.7	1.4	4.6	4.0
23 days after	3.0	5.8	3.9	1.0	1.0	4.5	5.0	2.1	4.0	0.9

TABLE IV. — EXPERIMENT II (continued)

Insecticide Diluent Mix Application Amount GROUP	40% DDT Barytes Mechanical Hand 17 oz. 40			40% DDT Cement Dust Mechanical Pump 8 oz. 41			40% DDT Cement Dust Mechanical Hand 16 oz. 42			CONTROLS		
	Ex	Pos	9 +	Ex	Pos	9 +	Ex	Pos	9 +	None		
										13	14	
SECTION A : Distribution of infestation and number of heavy infestations.												
	Ex	Pos	9 +	Ex	Pos	9 +	Ex	Pos	9 +	Ex	Pos	
1 day before	40	40	40	40	10	8	40	40	40	40	40	
7 days after	40	6	3	40	9	2	10	40	10	40	7	
14 days after	10	8	3	40	9	3	40	40	40	40	40	
21 days after	9	7	4	40	10	3	9	40	9	8	7	
28 days after	9	8	4	9	7	3	8	10	9	7	6	
SECTION B : Average number of lice of each stage, instar, nymph and adult.												
	I	N	A	I	N	A	I	N	A	I	N	
1 day before	plus	plus	plus	plus	plus	plus	plus	plus	plus	plus	plus	
7 days after	3.6	0.4	0.2	2.9	3.5	3.4	2.2	2.6	1.3	plus	plus	
14 days after	2.3	4.9	4.9	2.4	2.2	4.5	2.3	4.4	0.8	plus	plus	
21 days after	0.8	1.9	1.8	1.4	2.7	2.8	0.3	0.8	0.6	17.9	41.6	
28 days after	0.9	4.0	4.4	2.6	3.4	2.6	0.8	1.9	2.2	40.8	39.8	

duster (Toxine) without removal of the clothing. This was the first attempt to dust mechanically any considerable group of people. Unfortunately, owing to an unrecognized defect in the duster used, only about one-half as much insecticide was used on the machine dusted groups as on the shaker dusted groups.

The results of Experiment II (Table IV) are not as clear cut as one might wish, due in part to the large number of variables present. It is apparent, however, that even in the face of constant exposure to reinfestation, six of the eight test groups treated with the variously prepared and applied insecticides, had greatly reduced louse burdens one month after a single application. Only in groups 5 and 7, in which about one-half of the usual amount of 5% DDT per person was used, were the results poor. That these poor results were to be attributed to the small amount of DDT actually applied rather than to the method of application is suggested by the fact that the same amount of 10% DDT applied in the same way (groups 9 and 11) gave satisfactory results.

The data suggest that good results can be gotten when an adequate amount of 5% DDT is used, but that 10% powder affords a better margin of safety.

Epidemiologically, these results indicate that monthly powdering with DDT of persons subject to constant reinfestation will prevent them from becoming an important source of typhus dissemination.

No significant evidence was found for the superiority of solvent mixed over mechanically mixed powder. There is some suggestion that barytes may be a better diluent than is cement dust.

### *Experiment III*

Although the results with cement dust in Experiment II were not quite so favorable as those with barytes it was felt that the great advantage in weight justified further tests of DDT in cement dust. Experiment III was set up in Ward II, under conditions favoring heavy reinfestation to test:

- (1) 10% DDT in cement dust, to which had been added 2% cresyl acetate, applied by agricultural duster (Corona) by hand.
- (2) 10% DDT in cement dust without cresyl acetate applied by agricultural duster (Corona) and by hand.
- (3) MYL applied by Dobbins No. 133 duster and by hand.
- (4) Repeated hand picking and removal of lice from clothing.

The results of Experiment III (Table V) suggest the following conclusions:

1. DDT is slow to act but continues to exercise an influence on the louse population for several weeks.
2. The addition of 2% cresyl acetate to 10 % DDT powder is without apparent advantage.

3. MYL is more rapidly effective than is DDT but has a more limited residual action.

4. The mechanical application of insecticide without removal of the clothing gives results comparable with those observed after hand application. There is some suggestion in the results that the insecticide blown forcibly into the texture of the clothing may have a more prolonged effect than has insecticide which is just shaken on the cloth.

5. Weekly hand picking of lice from the clothing does not appreciably reduce the total louse population where reinfestation with adult egg-laying forms occurs constantly.

OBSERVATIONS ON LOUSINESS MADE DURING THE COURSE  
OF EXPERIMENTS I, II AND III.

It is apparent under the conditions of life at the Maison-Carrée Prison that the great majority of viable ova hatch before the 10th or 11th day after egg laying ceases. The fact that this period is so short may be in part explained by the fact that the prisoners wore their clothing day and night and that the warm weather persisted during the first two experiments.

The number of lice found on a given individual often varied from week to week in the absence of treatment. This was sometimes due to changing clothes, to washing clothes, and to very recent hand picking of lice.

Very few head lice were seen, possibly because the heads of the prisoners are close-clipped periodically.

Surprising numbers of lice and some ova were found on the blankets which were used only at night. The blanket undoubtedly served as an important source of reinfestation in Ward II where blankets were not powdered.

Lice were found to show a distinct preference for certain regions of the body. The seams at the armpit, the neck, the waist and the crotch were particularly favored. When only a few lice were present, they were generally confined to these areas. On the other hand, when a prisoner was heavily infested, lice were found widely distributed all over the clothing and bedding.

A very noticeable preference was noted for certain types of cloth. Cases were observed in which several hundred lice were present on the shirt with practically none on the trousers. In other cases large numbers of lice were counted on the trousers with few or none on the shirt. In these cases the distribution was correlated with the material and weave of the cloth in the garment. Those making the observations in the prison came to know which types of cloth were favored by lice and could predict the distribution on a given individual before examination.



TABLE V. — EXPERIMENT III (continued)

Insecticide Diluent Mix Application Amount GROUP	MYL Pyrophyllite Mechanical				HAND PICKING				
	SB ⊗ Pump 48 oz. 19	Hand 18 oz. 20	21		22				
SECTION A : Distribution of infestation and number of heavy infestations.									
	Ex	Pos	9 +	Ex	Pos	9 +	Ex	Pos	9 +
1 day before	40	40	10	40	40	40	40	40	9
4 days after	10	7	1	40	6	0	—	—	—
7 days after	10	7	2	40	40	4	40	40	7
14 days after	10	40	1	40	40	6	40	40	9
21 days after	40	8	3	9	9	5	40	40	8
28 days after	8	7	4	9	9	8	40	9	7
SECTION B : Average number of lice of each stage, instar, nymph and adult.									
	I	N	A	I	N	A	I	N	A
1 day before	27.3	28.8	17.6	17.2	22.6	11.6	18.0	18.1	26.7
4 days after	2.6	0.4	0.7	0.9	0.7	0.1	—	—	—
7 days after	4.4	3.3	0.5	6.3	2.9	0.4	14.7	36.7	32.9
14 days after	3.2	2.2	1.8	4.3	6.6	4.0	48.2	38.0	89.2
21 days after	2.3	6.1	2.1	1.9	8.2	5.4	64.1	18.7	34.4
28 days after	6.9	10.1	6.9	7.4	21.9	7.1	9.3	12.5	72.2
									10.6

⊗ SB : — « Superbuilt » hand pump (Dobbin 133).

TABLE V. — EXPERIMENT III (continued)

Insecticide Diluent Mix Application Amount GROUP	CONTROLS					
	23					4
SECTION A : Distribution of infestation and number of heavy infestations.						
	Ex	Pos	9 +	Ex	Pos	9 +
1 day before	10	40	9	10	10	9
4 days after	—	—	—	—	—	—
7 days after	40	10	8	9	9	9
14 days after	9	9	8	9	9	9
21 days after	9	9	9	9	9	8
28 days after	9	9	9	9	9	7
SECTION B : Average number of lice of each stage, instar, nymph and adult.						
	I	N	A	I	N	A
1 day before	7.7	44.0	3.9	9.4	33.9	5.2
4 days after	—	—	—	—	—	—
7 days after	47.4	34.4	6.2	8.3	69.0	44.8
14 days after	54.9	401.1	42.7	43.8	87.2	47.7
21 days after	27.9	55.2	45.6	48.9	71.0	44.4
28 days after	48.6	49.7	22.6	9.9	65.3	44.4

The average louse count increased rapidly after the cool weather began. The weather during July, August and September was hot and clear but a sudden change to colder and rainy weather came early in October. The louse count rose rapidly at this time (Table I, Groups 23, 24). This may be attributed to the fact that without adequate changes of clothing the men ceased to remove their clothing for washing, tended to huddle together indoors and often wore their blankets both day and night.

## SECTION II :

### FIELD PROGRAM IN L'ARBA COMMUNE, ALGERIA

The work at the prison had established the efficacy of MYL and DDT on people naturally infested with lice, but confined within narrow limits and subject to prison discipline. Before undertaking epidemic control with the methods used in the prison, it seemed desirable to get experience in delousing a civilian population in which individuals were free to come and go as they pleased. Discussions with Dr. Edmond SERGENT and Dr. BÉGUET of the Institut Pasteur, Algiers, and Dr. GRENOILLEAU, Director of Health for Algeria, led to the selection of L'Arba, which lies some 30 kilometers south of Algiers, as the site for such a study. Late in August, the commune of L'Arba was visited and the approval of the mayor and the Caid obtained for a delousing program, to begin in October, after the end of Ramadan.

Typhus had been present in L'Arba during the seasons, 1941-42 and 1942-43. Within the town proper live approximately 1500 Europeans, mostly French, and 3,500 Arabs. That lice were present in the community was demonstrated on the first visit. Rapid examination of the collars and shoulder yokes of the upper garments of several boys at the school, showed all to have lice.

It was hoped that information could be gained from the work in L'Arba on :

(1) means of establishing contact with and handling the people to be treated ; (2) methods of applying delousing powder to free civilians ; (3) type of records to be kept ; (4) availability of labor for the delousing of Arab populations.

It was decided that the delousing work at L'Arba would be based on the use of two applications of MYL powder per individual with an interval of fourteen days between applications.

Planning of the work provided for completion of all first treatments within three weeks and more than four weeks from the day the work started in the community.

## PRELIMINARY TRIAL IN LOTISSEMENT BUGAUD.

It was agreed with local officials of L'Arba that a demonstration of delousing methods would be conducted in Lotissement Bugaud, a section of ward-like subdivision near the town hall with some 600 inhabitants, mostly Arab.

The initial demonstration followed the general plan used in Mexico. The streets in the section were not named, and the houses did not have numbers. The first step, therefore, was the drafting of a map to orient teams of field workers.

The actual work of delousing began on October 11, 1943. Workers were organized into 3 teams of 3 members each — one person having had experience in the work at Maison-Carrée plus one male and one female assistant. Two of the women were French Public Health nurses. The third was an Arab girl, about 15 years old; permission had been obtained from her family for participation in the work, and it was hoped that her example would encourage other Arab women to accept employment. It was anticipated that the experience gained here would qualify these women for later supervisory work.

The population of the lotissement was divided into three approximately equal portions, and a section assigned to each team. The team carried a basket containing the following equipment: a map of the lotissement, a clipboard with two sets of forms, one for recording census, louse incidence and powdered individuals and the other a daily team summary, a piece of chalk for marking the house numbers, a flashlight, a supply of MYL powder in 2-ounce paper envelopes, a Dobbins «Superbuilt» hand duster, a 1-liter bottle containing a 5% emulsion of phenyl cellosolve lotion for treatment of heads, and a supply of absorbent tissues to protect the eyes of the subject during the treatment of his head.

Each team began work at a different designated point on the map. Arab houses are built around a central uncovered court and because the light was usually better and the space greater than in the rooms, most of the treatments were given in the courtyards. The number of the families in the court was determined; names and ages of the members of each family were listed on the individual record form under the father's name. The name of the wife followed that of the husband; the children were listed in order of their age. If there was more than one wife, children were listed under the mother's name. After completion of the family census the treatment of individuals began.

Usually in each household a child of 8-12 years was selected as the first individual to be deloused. The children regarded it as a game and were perfectly willing to submit to powdering. The

response of these children generally removed the hesitancy of older and younger members of the family.

Before application of powder, the collar, shoulder yoke and armpits of the upper garments were examined for lice. The presence of either lice or viable eggs was used as an index of lousiness. Lousiness was recorded as zero, slight or heavy.

Treatment of the subject began with the application of powder to the clothing. With the exception of the treatment of the head, the procedure used in applying powder to the clothing was that outlined previously.

When powdering of the clothing had been completed the person was seated, and the hair treated with phenyl-cellosolve lotion. The individual was given a piece of absorbent tissue and instructed to hold it in place against the forehead and over the eyes. Lotion was shaken from the bottle into the hair and rubbed in by hand until the hair was thoroughly wetted. The piece of absorbent tissue was then used to wipe the forehead and hair to prevent lotion from reaching the eyes. When treatment of all residents present in the house had been finished, the team moved to the adjoining house and so on until their section of the lotissement had been finished.

First treatments in lotissement Bugeaud were completed on October 14th. The second application started on October 18th and was carried out by a single team consisting of one doctor, a French nurse and the Arab girl. This second series of treatments was finished on October 25th. Results obtained are presented in Table VI:

TABLE VI

Total inhabitants	Refusals		Persons not treated		Persons treated once		Persons treated twice		Total No. treatments	Total No. man hours	Persons treated per man hour
	No.	%	No.	%	No.	%	No.	%			
680	12	1.7	60	8.8	620	91.2	454	66.8	1,074	258	4.2

The work in L'Arba was interrupted by the invitation of the Surgeon's Office NATOUSA to conduct a delousing demonstration in Prisoner of War camps. As personnel again became available to continue the program in L'Arba, a survey of the initial experience in lotissement Bugeaud showed that: (1) Arab men are not able to enter houses other than those of their immediate families and are of little use in house to house work; (2) treatment of Arab women and female children would have to be done entirely by doctors, nurses or women workers; (3) Arabs were willing to accept treatment (only 1.7 % of the inhabitants of lotissement Bugeaud refused to be treated) and (4) Arabs expressed their appreciation at being

freed of lice, fleas and other body-infesting insects. While the difficulty of obtaining employees for delousing Arab women remained a problem of considerable importance, the willingness of the Arabs to accept delousing measures and their desire for additional work in the community encouraged the consideration of a larger program in the area.

#### EXPANSION OF PROGRAM IN L'ARBA COMMUNE

On November 2nd, the mayor of L'Arba and Monsieur Mohied-dine, grandson of the Caid, were consulted regarding the expansion of the delousing program. Since the men from the douars or mountain districts came in to L'Arba at least once a week to trade they would be a constant source of reinfestation for the villagers if they and their families were unpowdered. This would mean the treatment of approximately 10,000 additional persons, but it offered an opportunity to gain valuable experience. Moreover lousiness in the douars was universal and typhus frequently made its first appearance in these areas.

If delousing measures were to be undertaken in the douars, the people living on the farms should also be included. It was decided therefore to accept the limits of the commune (county) of L'Arba as the boundaries for the delousing program. This area encompassed the town of L'Arba with a population of some 1500 Europeans and 3500 Arabs, the 6 mountain douars with roughly 8000 inhabitants and approximately 100 Europeans and 1900 Arabs living on the various farms on the plain north of the town.

The primary obstacle to the execution of the enlarged program was the non-availability of female assistants. For a variety of reasons connected with the war, full employment of the menfolk, local, social and racial prejudices, inability to transport and feed imported personnel, etc., the bulk of the work would have to be done with a very limited amount of assistance. The entire project was ultimately carried out by two staff supervisors, two public health nurses and a 15 year old Arab girl to powder the Arabe women. They were aided from time to time by the leader of the local Girl Scout organization, two of her friends and some of their young charges working on a voluntary basis.

A central base of operations was established in a combination garage-stable located in the first floor of a dwelling house. This was the most suitable site available and it served as headquarters, powdering station and supply depot. Three of the staff found living accommodation with the family occupying the house.

In spite of these unimpressive facilities and the nature of the problem being attacked as well as the doubts expressed by early advisors, the project was well received and won the active cooperation of the local religious, educational, political and medical leadership.

*Village house-to-house dusting.* — It was decided to start the delousing work in L'Arba in the section of the town known as Lotissement Eglise. The mayor and the representative of the Caid felt that the Arabs would be more receptive to the program if house to house work was used in the beginning as had been done in Lotissement Bugeaud. In accordance with their wishes the work in Lotissement Eglise was planned on this basis.

In general the sections of the town in which the Arabs live do not have named streets and numbered houses. Since it was desired to have a record of the location of treated and untreated families and individuals, the first step was the drafting of a map. A rough sketch map was considered sufficient for the purpose of locating individual families and for assigning work to the census and delousing teams. The limits of the lotissements of L'Arba are quite definite and are generally known by the residents of the town; this greatly facilitated mapping. Several copies of the map were then made, so that one could be supplied to each of the powdering teams.

The lotissement was divided into three approximately equal areas. The work assignment for a given delousing team was indicated on the map supplied it. Teams were directed to begin at the lowest number and work the families in order.

The powdering teams for Lotissement Eglise were made up of three females each; one recorded the census of the family while the two others applied the insecticide.

MYL was used on both the head and clothing in treating Lotissement Eglise, since the liquid pediculicide for the head required extra equipment and material. The women offered no objection to having their heads powdered.

*Temporary Powdering Stations in L'Arba Village.* — House-to-house work as conducted in the Lotissement Eglise gave a relatively high percentage of coverage (91.8) but the number of treatments per man hour of work was low. Inquiries showed that a fair proportion of the inhabitants of Lotissement Djipoulou were willing to come to the djama or community house to be dusted. The area was therefore mapped and censused and the people notified when to present themselves at the djama for powdering. As they appeared and were treated they were checked off on the census lists. This system resulted in an increase in the number of persons treated per man hour of work.

A further modification in the plan of operations was made in Lotissement Medjabri because it had been found in Djipoulou that valuable working time was lost in checking the census lists to locate the names of applicants for treatment. In order to overcome this difficulty when the census of Lotissement Medjabri was made each family was given a numbered ticket which was to be presented

when it appeared at the powdering station. This proved to be satisfactory and effected a further saving in time per treatment.

In those lotissements which had no djama or community house, the cooperation of influential residents of the area was enlisted and temporary powdering stations were set up in the courtyards or other convenient places in the residences of private citizens. Sometimes only the women and girls were dusted at these stations while the men and boys were asked to go to the central powdering station to be treated.

These various schemes of operation at temporary powdering stations in the lotissements were combined with a program of « clean-up » work so as to reach those who had failed for one reason or another to present themselves at the temporary treatment centers. A small squad armed with the census list called at the home of each family that had been missed according to the checked census record. As a rule the girls and women reached in their homes during the daytime by the follow-up squad. The men and boys were accommodated at a temporary station which operated at a set time after working hours in the early evening. This type of follow-up dusting helped greatly to maintain the relatively high percent of coverage obtained in the L'Arba lotissements.

*Temporary Powdering Stations in the Commune outside the Village of L'Arba.*

The delousing program in the douars or mountain districts outside the village of L'Arba was arranged through the cooperation of the Mayor and the Chefs de Fractions, or district leaders. Mapping and census of these outlying regions was not practical due to the scattered nature of the population and the difficulties of communication. The Chef de Fraction therefore assumed the responsibility of having the inhabitants of his districts at a convenient and suitable point in the douar for powdering at a designated time. Names were listed as the people were dusted and separate facilities were provided for the treatment of males and females. Estimates of the coverage in the douars were made by checking the lists of persons treated against the number of ration cards issued for the district.

The farms in the L'Arba plain were handled as individual units. Arrangements were made with the owner as to a suitable time and place for the dusting. He prepared lists of his employees and their families for use by the powdering squads. The men were usually treated at some central point on the farm while the women and children were dusted at the « gourbis » or family dwelling places.

*Permanent Central Powdering Station.*

The name, age, sex and address of those coming to the permanent powdering station were recorded. Checking these lists presented

many difficulties but insofar as possible the individuals who came to the station were credited to the lotissements, douars or other subdivisions where they resided. This detail was somewhat simplified after the introduction of numbered tickets. The station was kept open until 7 P.M., every day and the bulk of its patrons were older men, youths and children; women seldom came.

In addition to the central powdering station a certain amount of dusting was done in the market place on Wednesdays and Sundays, the local market days. Records of this work were kept and treated in the same manner as those at the central station.

#### *Institutional Delousing.*

Early in the L'Arba program arrangements were made with the local school authorities for the delousing of the school children in their class rooms. The effectiveness of the treatment would thus be demonstrated in homes throughout the community and it was hoped that this would facilitate the general acceptance of the program by the adults.

With the assistance of the directors and teachers the work was carried out in both the boy's and girl's schools. The only difference in handling of the two groups being the application of the hair lotion to the hair of the girls. Most of the boys wore their hair very short and it was easier to treat them with powder than with lotion.

Records were kept of the names and addresses and the incidence of lousiness among the pupils.

#### DISCUSSION OF RESULTS.

During the course of the delousing project in L'Arba 9,376, or 66.8% of the 14,030 Arab inhabitants of the commune were powdered. There were 4,241, or 30.2%, dusted twice and 4,671, or 33.2%, were not treated.

Tables VII and VIII show the number of percent of first and second treatments and the number of persons treated per man hour of labor.

Table IX presents a comparison of results in house-to-house contacts and the use of temporary powdering points.

The breakdown of powdered individuals into sex and age groups is given in Tables X and XI.

*Personnel.* — The primary problem of the L'Arba program was the shortage of female assistants to work with Arab women. It is impractical to attempt large scale delousing in the region relying only on professional personnel such as doctors and nurses to powder the Arab women. With the greatly inflated family incomes

TABLE VII. — FIRST AND SECOND

Location	Census	Persons not powdered	
		Number	Percent
Lotissement Eglise.....	293	24	8.2
Lotissement Djipoulon.....	452	32	7.0
Lotissement Medjabri.....	522	66	12.6
Lotissement El Fass.....	804	100	12.4
Lotissement Moll.....	365	53	14.5
Lotissement Boulevard de France.....	471	69	14.6
Lotissement Duc d'Aumale.....	209	43	20.6
Lotissement Boulevard Lamartine.....	101	22	21.8
Lotissement Rue Carnot.....	77	5	6.4
Lotissement Rue Blandan.....	207	37	17.9
TOTAL for Lotissements.....	3,501	451	12.9
Ecole de Garçons.....	407	7	1.7
Ecole Primaire de Filles.....	234	4	1.7
Civil Prison.....	20	0	0
Powdering Station.....			
GRAND TOTAL.....	4,462	462	11.4

Census made by delousing personnel as part of the work of the delousing program.

## TREATMENTS IN L'ARBA VILLAGE.

Persons powdered		Persons powdered twice		Total number treatments	Total number man hours	Persons treated per man hour
Number	Percent	Number	Percent			
269	91.8	198	67.6	467	88	5.3
420	93.0	286	63.3	796	112	6.3
456	87.4	340	65.1	796	95	8.3
704	87.6	424	52.7	1,128	176	6.4
312	85.5	153	41.9	465	86	5.4
402	85.4	224	47.6	626	88	7.1
166	79.4	69	33.0	235	32	7.3
79	78.2	30	29.7	109	6	18.1
72	93.6	33	42.8	105	10	10.5
170	81.4	74	35.7	244	14	17.4
3,050	87.1	1,831	52.3	4,881	707	6.9
400	98.3	353	86.7	753	74	10.2
230	98.3	149	63.7	379	41	9.2
20	100	13	100*	33	4	8.3
418**				418**	88	4.8
3,700	88.9	2,346	56.4	6,046	914	6.6

\* Other prisoners had been released during interval between treatments.

\*\* Treated at L'Arba powdering station, but assigned and counted in individual lotissements.

TABLE VIII. — FIRST AND SECOND

Location	Census	Persons not powdered	
		Number	Percent
Douar Tenout.....	166 *	0	0
Douar Sakamody.....	450 **	0	0
Douar Zerhout.....	1,186 **	306	25.8
Douar Bousequine.....	1,435 **	495	34.5
Douar Sohane.....	1,287 **	791	61.5
Douar Khodja and Bakir.....	3,125 **	2 540	80.5
Powdering Station.....			
TOTAL for Douars.....	7,649	4,110	53.7
Mohieddine District.....	***		
Bohane District.....	***		
Powdering Station.....			
Farm Sainte Angèle.....	55 *	0	0
Farm El Taous.....	126 *	25	19.8
Farm Grandou.....	138 *	0	0
Farm Ben Assen.....	279 *	24	8.6
Farm Couderc.....	5 *	0	0
Farm Claret.....	37 *	0	0
Farm Tordjmann.....	97 *	0	0
Farm Vallot.....	31 *	0	0
Farm Vidal.....	25 *	0	0
Farm Bouchtop.....	35 *	0	0
Farm Belgodene.....	26 *	0	0
Farm El Euldj.....	38 *	0	0
Farm Valero.....	12 *	0	0
Farm Saint Philippe.....	61 *	0	0
Farm Lagae.....	13 *	0	0
Farm Ben Nouar el Louz.....	166 *	0	0
Farm Mohieddine.....	84 *	0	0
Farm Kadem.....	27 *	1	3.7
Farm Mokhfi.....	296 *	0	0
Farm Sarraoui.....	31 *	0	0
Farm Cherabas.....	153 *	0	0
Farm Cheragas.....	55 *	0	0
Farm Rachdi.....	55 *	0	0
Farm Bealaoudi.....	69 *	0	0
Powdering Station.....			
TOTAL for Farms.....	1,914	50	2.6
GRAND TOTAL.....	9,849	4,160	42.2

\* Census taken by the powdering team at the time of treatment. — \*\* Census according to the ration cards supplied by the Office of the Mayor, L'Arba. — \*\*\* Complete census not available. — \* Due to weather conditions and impassable roads.

## TREATMENTS OUTSIDE L'ARBA VILLAGE.

Persons powdered		Persons powdered twice		Total number treatments	Total number man hours	Persons treated per man hour
Number	Percent	Number	Percent			
166	100	71	42.8	237	63	3.8
467	100	252	50.0	719	75	9.6
880	74.2	171	14.4	1,051	113	9.3
940	65.5	83	5.9	1,025	112	9.2
496	38.5	121	9.4	617	76	8.1
607	19.5	95	3.0	702	113	6.2
287 **				287	60	4.8
3,556	46.3	795	10.3	4,351	612	7.1
104		90		194	47	4.1
182		88		270	24	11.3
12 **				12 **	3	4.0
55	100	55	100	110		
101	80.2	41	32.5	142		
138	100	95	68.8	233		
255	19.4	147	52.6	402		
5	100	*		5		
37	100	28	75.7	65		
97	100	81	83.5	178		
31	100	29	93.5	60		
25	100	20	80.0	45		
35	100	27	77.1	62		
26	100	12	46.2	38		
38	100	29	76.3	67		
12	100	4	33.3	16		
61	100	52	85.2	113		
13	100	13	100.0	26		
166	100	58	34.9	224		
84	100	53	63.1	137		
26	96.3	11	40.7	37		
296	100	205	69.3	501		
31	100	23	74.2	54		
153	100	*		153		
55	100	*		55		
55	100	*		55		
69	100			69		
166 **				166 **	35	4.8
1,864	97.4	983	51.4	2,847	465	6.1
5,706	57.8	1,956	19.8	7,662	1,186	6.6

ability of roads no visit made for second treatment — \*\* Treated at L'Arba powdering station, but assigned and counted in individual douar (farm) totals.

TABLE IX. — COMPARISON OF HOUSE-TO-HOUSE DUSTING AND TEMPORARY POWDERING STATIONS.

Location	Census	Persons not powdered		Persons powdered		Persons powdered twice		Total number treatments	Total number man hours	Persons treated per man hour
		Number	Percent	Number	Percent	Number	Percent			
Lot. Bugeaud *	680	60	8.8	620	91.2	436	66.8	1,074	258	4.2
Lot. Eglise *	293	24	8.2	269	91.8	198	67.6	467	88	5.3
Total.....	973	84	8.6	889	91.4	632	67.0	1,541	346	4.5
Lot. Djipoulou **	454	32	7.0	420	93.0	286	63.3	706	112	6.3
Lot. Medjahri **	522	66	12.6	456	87.4	340	65.1	796	95	8.3
Lot. El Fass **	804	100	12.4	704	87.6	424	52.7	1,128	176	6.4
Total.....	1,778	198	11.1	1,580	88.9	1,050	60.0	2,630	383	6.9
Total for House-to-House	973	84	8.6	889	91.4	632	67.0	1,541	346	4.5
Total for Temporary Centrally Located Powdering Points.....	1,778	198	11.1	1,580	88.9	1,050	60.0	2,630	383	6.9

\* Census taken at time of powdering.

\*\* Census taken and ready for use at time of powdering.

of war time Arabe women are not willing to work outside their homes. With the return of peace and the easing of transportation and food problems it may be practical to import female assistants from the urban centers where some Europeans and less orthodox Arab women are to be found. On the other hand, if a community were actually confronted with epidemic typhus, local leadership would probably become more effective in solving this problem.

TABLE X : DISTRIBUTION OF TREATED INDIVIDUALS BY SEX AND AGE GROUPS AMONG THE ARAB INHABITANTS OF L'ARBA VILLAGE.

Age group	No. of individuals	Untreated		Treated		Powdered twice	
		No.	%	No.	%	No.	%
Men over 16.....	1,071	369	34.5	702	65.5	206	19.2
Boys 2-16.....	948	54	5.7	894	94.3	563	59.4
Women over 16.....	1,079	56	5.2	1,023	94.8	711	65.9
Girls 2-16.....	808	24	2.9	784	97.1	613	75.9
Infants 0-2.....	275	8	2.9	267	97.1	192	69.8

*Problems of Community Delousing.* — The favorable reception of the delousing treatment by the citizens of L'Arba is better indicated by the low percentage of refusals (1.7% Table VI), than by the percentage of over-all coverage in the community as a whole. The obvious effectiveness of the anti-louse powder and the personal convenience and ease of applying it without removal of the clothing were primarily responsible for the results attained.

Racial discrimination, a question which was raised during the formative phase of the program, never became a problem because the European, both at school and in the home, accepted the treatment without protest.

Aside from the personnel difficulties already mentioned, the major problem of the project was administrative: What practical method would reach the greatest number of people? The treatment was acceptable, but experience showed that it was not as actively sought for as might be expected in such a generally infested population. The character of the response may perhaps be explained in large part by two factors: the almost Oriental indifference of the Arab born of long association to the discomfort and danger connected with blood-sucking ectoparasites, freedom from which the majority of the people have seldom or never known, and the multitude of proscriptions that so completely hedge and limit the activities of Arab women.

By far the simplest administrative procedure is to set up a central powdering station and invite the people to come to it for treatment. But during the month of its operation the central powdering station in L'Arba was utilized by only 10% of the village inhabitants as compared to 8.7% of the farm dwellers and 3.9% of those living in the douars. Moreover, 92.7% of the patrons at the central station and 95.8% of those treated at the market place in L'Arba were males (Table XI). It is very probable that had other delousing work been going on simultaneously in the lotissements the response at the central station would have been much greater. Nevertheless, it is evident that this system would fail to reach most of the females and very young males. It appears, therefore, that the treatment must be made more convenient by bringing the facilities closer to the home and establishing rather direct contact with the people as was done by the house-to-house work and the use of temporary powdering stations in the lotissements, farms and douars.

TABLE XI. — SEX AND AGE DISTRIBUTION OF TREATMENTS IN THE DOUARS AT THE POWDERING STATION AND IN THE MARKET PLACE OF L'ARBA.

Location	Number and Percent of Various Age Groups Treated										
	Total treat- ments	Males 16 +		Females 16 +		Males 2-16		Females 2-16		Infants 0-2	
		No.	/o	No	o/o	No	o/o	No.	o/o	No.	o/o
<i>Douars</i>											
Tenout.....	166	36	21.7	39	23.5	42	25.3	34	20.5	15	9.0
Sakamody..	467	133	28.3	91	19.5	123	26.3	105	22.5	15	3.2
Zerbout.....	880	180	20.5	230	26.1	211	23.9	207	23.6	52	5.9
Bouseguine.	940	187	19.9	233	24.8	223	23.7	237	25.2	60	6.4
Sohane.....	496	129	26.0	127	25.6	119	23.9	108	21.9	13	2.6
Kodja and Bakir.....	607	220	36.2	95	15.7	173	28.5	94	15.5	25	4.1
<i>Districts</i>											
Mohieddine..	405	14	13.3	30	28.6	36	34.3	18	17.4	7	6.7
Bohane.....	182	34	18.7	46	25.3	42	23.1	42	23.1	18	9.8
TOTAL...	3,843	933	24.3	891	23.2	969	25.2	845	21.9	205	5.4
<i>Powdering Station... Market Place</i>											
Powdering Station....	667	486	72.9	5	0.7	132	19.8	37	5.5	7	1.1
Market Place	216	146	67.6	1	0.5	61	28.2	7	3.2	1	0.5
TOTAL...	883	632	71.6	6	0.7	193	21.9	44	4.9	8	0.9

Considering the distance involved and the difficulties of communication the response in the douars is worthy of comment. Many of the people in these mountain districts travelled on foot for several hours to reach the wayside powdering station in the hills. In two of the six douars all of the inhabitants came in for the first treatment while in two others between 65 and 75% of the residents were dusted. In the remaining two, Khodja and Bakir, which were the largest and the ones therefore where travel and communication the most difficult, the response was poor. They brought the over-all percentage for all the douars down to 46.3. This figure is to be compared with 87.1% coverage in the lotissements of L'Arba village, where pre-census and house-to-house clean-up work established direct contact with the greater part of the population. In the douars explanation of the program and notification of the time and place of the dusting was the sole responsibility of the Chefs de Fractions and the success of the work there was determined by the extent of their cooperation. Unlike the people in the village those in the douars had not the benefit of a convincing preliminary demonstration such as that in Lotissement Bugeaud, which greatly facilitated the work in the other lotissements of L'Arba.

In the village of L'Arba itself where 87.1% of the population was dusted, 72.2%, (Table X) of the untreated group were males over 16 years of age. Of the adult males only 65.5% were dusted, whereas 94% of the rest of the population were powdered. Most of the adult males were employed, many of them on night shifts, in the military installations and depots in the area and it is believed that absence from home and personal inconvenience rather than a reluctance to be treated accounts for the high proportion of untreated males over 16 years of age. This interpretation is supported by the fact that in the douars where the men were engaged in the fields the proportion of treated and untreated adult males was about the same as that observed in the other population categories (Table XI).

While the reaction to different administrative methods varied from one part of the community to another it is believed that in normal times a sustained delousing program would meet with a very favorable response in a population familiar with its benefits.

*Second Treatments.* — A single treatment gave prompt relief from the discomforts of being lousy, which persisted beyond the date set for retreatment. The result was that the people could not be convinced of the need of exerting themselves to seek a second treatment so soon. In the douars where the most effort was required to get treatment, only 10.3% of the inhabitants presented themselves for the second powdering (Table VIII). In the village of L'Arba where relatively little effort was involved, only 52.3% were treated a second time (Table VII). The smallest percentage of second treat-

ments was among adult males, again the group that would have to exert itself the most to be re-treated.

*Costs of the L'Arba Delousing Project.* — The figures listed are based only on necessary expenditures for insecticides, payroll, transportation and storage; staff salaries are not included:

Total expenditures .....	\$ 1580.10	
Total people treated (once) .....	9406	
Cost per person .....	16.8	
Total number treatments given.....		13,708
Cost per treatment .....	11.5	
Cost of insecticide per treatment .....	6.5	
Cost of labor per treatment .....	1.6	
Cost of transportation par treatment ....	2.5	

The high cost of the insecticide was largely due to the fact that it was packaged in specially designed shaker envelopes which had to be hand filled. The use of the hand dust pump made the special envelopes unnecessary but the production costs were included in the purchase price of the insecticide. Bulk powder is preferable for use in dust pumps and much less expensive.

Transport charges were inordinately high due to the scarcity of vehicles and the market price of fuel. Much of the work in the douars and farms was done with a truck hired at the rate of \$ 20 per day.

In normal peacetime the cost per treatment would probably be reduced to about one third that of the experimental program.

*Treatments per Man-hour.* — Tables VII, VIII and IX include data on the number of persons treated per man-hour of work in the village, the douars, farms and institutions. Man-hours are calculated on the basis of the total number of hours for which the workers were paid—not the actual time spent in dusting, census-taking etc. The time spent going to and from a given place of work is included in the man-hours charged against each farm, douar, or lotissement. In the lotissements of the village the time spent in travel was slight, whereas it represents a very considerable part of the man-hours charged against the work in the douars. In small units such as lotissements Lamartine, Carnot and Blandan the women and girls were done by a single worker going from house to house while the men and boys were done at the central station. The result in these small units is an appearance of greater efficiency when compared with the larger units where several crews were at work.

*Control of Lice.* — Among the working class people and farmers of the L'Arba commune lousiness was almost universal. Indirect qualitative evidence of the success of the work was not lacking. Those who came for a second treatment frequently expressed their delight at being able to sleep undisturbed by lice, many of them for the first time since they could remember. Oftentimes workers were offered two to four eggs, worth 25 or 30 cents each, in exchange for

a packet of powder. One or two enterprising young workers had to be discharged when it was discovered that they had stolen envelopes of powder and sold them at stiff black market prices as high as 70 cents each. Since there is little conceivable misuse to which the powder could be put these incidents indicate that the value of the insecticide was thoroughly appreciated and suggest that were it possible to market the powder through normal commercial channels the community might do much for itself in suppressing lousiness.

*Control of Typhus.* — There was no opportunity to determine the effectiveness of the delousing at L'Arba in the control of typhus. While typhus had been present in the area during the two previous winters, no cases were reported during the time the work was in progress nor were cases of typhus reported in neighboring communes. The opportunity of collecting data on the prevalence of typhus was lost by the transfer of Rockefeller Foundation personnel to Italy to organize the campaign against typhus in Naples early in December, 1943.

### SECTION III : PRISONER OF WAR CAMP DEMONSTRATIONS

#### *(Field Test of 10% DDT-Pyrophyllite Powder)*

The experiments in the Maison-Carrée prison and the preliminary field test at L'Arba amply showed the practical nature of the method of applying insecticide to infested individuals without removing their clothing. Recognising the advantage of this technique in the handling of prisoners of war, the Surgeon's Office NATOUSA invited the Rockefeller Foundation Typhus Team to stage a series of demonstrations in the Mediterranean area. The invitation was accepted and arrangements were made for demonstrations in Algeria, Morocco, Tunis and Sicily during October and November.

A small stock of the U.S. Army's recently adopted 10% DDT-pyrophyllite louse powder was available and it was decided to field test this new preparation in one of the Prisoner of War (POW) camps where demonstrations were to be held. The following is a brief summary of the conditions under which the test was carried out and the results observed. The work was done with the full co-operation of the Base Section Surgeon, the commanding officer of the POW camp and with the assistance of U.S. Army Sanitary Corps Malaria Control Units in the area.

A stockade made to hold approximately 1500 prisoners at one of the Algerian POW camps was selected and work was started on 18 October, 1943. The commanding officer agreed not to add new prisoners to the stockade after the powdering had been done, but did make some withdrawals during the period of observation.

The prisoners lived in pyramidal tents which were numbered individually and by row. Tents in various parts of the stockade were chosen at random and their occupants thoroughly searched for lice. Using the technique previously described, the examinations were made under the supervision of the Typhus Team by 12 enlisted men of the Sanitary Corps under the command of Lt. J. F. STALLWORTH. Records were kept of the name and location of each man examined and of the number and developmental stages of the lice discovered. The clothing of 252 prisoners was examined and 193 (77%) were found to be infested. Of the 193 men 75 (30%) had ten or more lice.

The application of powder with Dobbins « Superbuilt » No. 133 hand dusters began on October 19th and was completed the following morning. It is of interest to note that although the enlisted men of the Sanitary Corps started the dusting of the prisoners, within a short time they had the prisoners themselves doing the dusting under their supervision. All of the garments worn by the prisoners together with extra clothing and blankets were powdered. Between 1300 and 1400 prisoners were dusted.

On November 4th, after a lapse of 16 days, two of the Typhus Team returned to the POW camp to supervise the follow-up examination and to observe the effectiveness of this first field test of 10% DDT louse powder. The examinations were made by the same personnel as before. Of the 252 prisoners whose garments had been searched previously, 152 were still in the stockage. The examination of the clothing of 151 of these men failed to disclose lice. On the 152nd man 8 nymphal and 2 adult lice were found. Upon questioning, this man said that he had been admitted to the hospital on the evening of the preliminary examination and that he had returned to the stockage after the dusting crews had finished on October 21st and thus had escaped being dusted. His statements were confirmed by an inspection of the Infirmary records.

It was concluded from these observations that, (1) the technique of applying insecticidal powder without removal of the clothing was a thoroughly practical procedure, even when carried out by unskilled personnel and that (2) the 10 % DDT-pyrophyllite powder is a highly effective preparation.

Other demonstration were held in Morocco on October 22nd, in Tunis on November 12th and in Sicily on November 16th.

#### SUMMARY

Field work to test the efficiency of louse powders on naturally infested population groups and to develop methods for the rapid application of louse powders was carried out in North Africa during the second half of 1943. The powders tested were MYL and

various combinations of DDT. Observations were carried out in a civilian prison, in a rural county with both European and Arab populations and in prisoner-of-war camps. Administrative techniques tested included, (1) House-to-house block dusting (2) Delousing stations (3) Local temporary delousing stations open only for a day at a previously notified time and place (4) Farm-to-farm delousing (5) Institutional delousing. In the early tests in North Africa, the powder was dusted by hand from shaker tins to the inner surfaces of garments which had been removed from the wearers. In August, the first demonstration was made of the possibility of satisfactorily powdering the clothing without removal from the body. This was followed by tests of various types of hand and power operated dusting equipment.

### CONCLUSIONS

1. In a closed population group where everyone is treated and the group protected from reinfestation from untreated groups, two treatments of either MYL or DDT at an interval of a fortnight may be expected to reduce lousiness immediately and prevent a dangerous degree of infestation during a 3 month period. Louse eradication in such a closed population should be possible with a few additional treatments.

2. Individuals, living, working and sleeping, in close contact with heavily infested population groups, show a very low infestation one month after a single treatment with DDT powder. Monthly powdering of native labor groups should almost eliminate all risk of such groups spreading typhus to the people with whom they come in contact.

3. MYL is more rapidly effective than DDT but has a more limited residual action. DDT continues to influence the degree of lousiness for several weeks.

4. The mechanical application of insecticide without removal of the clothing gives results comparable with those observed after careful hand application. There is some suggestion in the results that the insecticide blown forcibly into the texture of the clothing may have a more prolonged effect than has insecticide shaken on the cloth.

5. Vermin infested populations welcome the application of insecticidal powders and will make some effort to be treated. The choice of administrative technique used will depend on the distribution of the population to be treated, the existence of transportation facilities, and the personnel available to do the work.